radiant burner surface area and the excess combustion air operating air ratio is controlled in the range of 30% to 100% (wherein the excess air ratio is defined as percent combustion air in excess of the stoichiometric amount required for complete combustion of the burner fuel) to prevent overheating of the surface of the radiant burner and to prevent overheating of the premixed fuel and oxidant contained within the burner core. In the present invention, the reactant mass velocity is controlled in the range of 400 $lb/ft^2/h$ to 1500 $lb/ft^2/h$ in order to limit the reaction chamber tube wall temperature to the desired range of 1300°F to 1500°F.

Combustion products emanating from the permeable metal fiber zone 14 enter the inlet 13 leading to the convection chamber 17, wherein the combustion products exchange heat with tubular reaction chamber 1 for preheating the feed to leg 1b.

EXAMPLE

A compact endothermic catalytic reaction apparatus according to the preferred embodiment was constructed and tested. The reaction chamber consisted of 1 inch schedule 40 pipe constructed of 310 stainless

steel that was formed in a U-tube arrangement spaced on 3 inch centers. The reaction chamber was packed with a commercial steam reforming catalyst that was crushed and screened to an average particle size of approximately ¼ inch.

The radiant burner consisted of 4 inch long by 1 ½ inch outer diameter cylindrical assembly that had an active radiant angle γ_1 of 120 degrees. The burner assembly was placed in an insulated combustion chamber having dimensions of 6 inch internal diameter and 10 inch height. The radiant burner assembly was spaced approximately 4 inches from the U-tube centerline. The convection chamber consisted of a 2 inch tube constructed of 304 stainless steel.

The radiant burner was fired using a mixture of propane and air at a total higher heating value firing rate of 12,000 btu/h. The reactant mixture consisted of 1 lb/h of propane and approximately 3.5 lb/h of steam and was fed to the reaction chamber at a temperature of approximately 800°F. The reactant mixture was heated in the reaction chamber to an exit temperature of 1250°F. The measured tube wall temperature of the reaction chamber was 1450°F, the radiant burner surface temperature was 1750°F, and the combustion products exit temperature was 1050°F. The

estimated hydrogen plus carbon monoxide yield was 67 SCFH.

Fig. 3 depicts another embodiment of the present invention. In this embodiment, a radiant burner surface 30 having a hemispherical geometry radiates energy to the reaction chamber like that of Fig. 1. A mixture of fuel and oxidant enters the radiant burner from an inlet conduit 31. The longitudinal axis of the inlet conduit is oriented normal to the plane of the U-tube reaction chamber.

Fig. 4 depicts yet another embodiment of the present invention. In this embodiment, the reaction chamber is defined by a volume enclosed by a tubular reactor conduit comprising an upper section 19 consisting of a vertically disposed tube that is connected to the inlet means 2, a lower section 20 consisting of a helical coil, having an outer diameter between 6 and 36 inches, and an exit section 21 consisting of a vertically disposed tube that is connected to an exit means 3. The upper section 19 of the tubular reactor conduit passes concentrically through the convection chamber 17. The reaction chamber is packed with catalyst from the inlet means 2, where reactants enter, to the outlet zone 22 of the